**Assessment of Foetal Maturity and Wellbeing**

**Antenatal**

* Clinical assessment.
* Ultrasonography.
* Daily foetal movement count.
* Antenatal cardiotocography.
* Biophysical profile.
* Amniotic fluid study.
* Hormonal studies.
* Vaginal smear.
* Amnioscopy.
* Foetoscopy.
* Chorionic villus biopsy.
* Radiological methods.

**Intranatal**

* Monitoring of the foetal heart rate.
* Monitoring of the uterine contractions.
* Foetal blood sampling.
* The partogram.
* Recent advances in intranatal monitoring.

**CLINICAL ASSESSMENT**

Clinical examination in each antenatal visit is the primary and main assessment of foetal wellbeing. This includes detection of:

* foetal heart sound,
* foetal size,
* fundal level
* amount of amniotic fluid.

**ULTRASONOGRAPHY**

**Real-time sonography**

It can be used for detection of:

* Gestational age: by measurement of gestational sac, crown rump length, biparietal diameter or femur length.
* Viability of the foetus: by foetal heart movement or foetal movement.
* Foetal weight.
* Amniotic fluid volume.
* Foetal breathing movement. 6-Foetal activity.
* Placenta: location, size and maturity.
* Congenital anomalies.

**Doppler ultrasound**

***Principle***

It depends upon the reflection of the ultrasound waves on the RBCs inside the blood vessels, so the blood velocity and flow through these vessels can be calculated.

***Application***

* Detection of foetal heart rate as early as 10-12 weeks.
* Assessment of foetal cardiac function.
* Measurement of blood flow in high risk cases as IUGR, post-term pregnancy and pregnancy induced hypertension.

**DAILY FOETAL MOVEMENT COUNT (DFMC)**

**Procedure**

* The test is valid after 30 weeks of pregnancy.
* The mother counts the foetal movements she feels in 3 hours during the period of 12 hours e.g. from 9 am to 9 pm, one hour at the beginning, one hour at the middle and one hour at the end of this period.
* The count is multiplied by 4 to get the foetal movements in 12 hours. If it is less than 10 movements, this indicates that the foetus may be at risk and non-stress test is indicated.
* Count-to -ten Cardiff system: The mother counts the foetal movements from 9 am till she reaches 10 movements. No further count is needed unless she did not count 10 movements in up to 12 hours.
* It was found that there is a reduction or cessation of the foetal movement 12-24 hours before stoppage of the heart " movement alarm signal".

**Advantages**

* Informative and non-invasive.
* Pregnant woman can monitor herself.
* No cost.
* Accurate gestational age not required.

**Drawbacks**

* Awareness of the foetal movement is differ from a mother to another.
* Cessation of foetal movement may occur due to intrauterine sleep.
* Sedation of the foetus occurs if the mother is taking sedatives.
* Sudden death of the foetus may occur without preceding slowing of the foetal movement as in abruptio placentae or it may be preceded by increased flurry movements.

**ANTENATAL CARDIOTOCOGRAPHY**

**Non-stress Test**

***Indications***

* Decrease foetal movement (<10/12 hours) or its cessation.
* Intrauterine growth retardation especially with a major cause as pre-eclampsia.
* Foetal danger as in antepartum haemorrhage.
* Biochemical evidence of placental insufficiency.

***Procedure***

* It is done starting from the 30 weeks of pregnancy.
* The electronic foetal monitor is used during pregnancy to record the pattern of foetal heart rate (FHR) and its response to the foetal movements reported by the mother by pressing a button in her hand.
* The test is carried out for 20 minutes. If foetal movement did not occur the test is extended for another 20 minutes during which the foetus is stimulated mechanically by the 1st pelvic grip or by acoustic stimulation using an artificial larynx placed against the maternal abdomen to " awaken the foetus" .

***Results***

* Reactive test: 2 or more foetal movements are accompanied by acceleration of FHR of 15 beats/ minute for at least 15 seconds’ duration. Reactive test means that the foetus can survive for one week, so the test should be repeated weekly.
* Non -reactive test: no FHR acceleration in response to foetal movements so contraction stress test is indicated.

**Contraction Stress Test (Oxytocin Challenge Test)**

***Procedure***

* It is done after 32 weeks of pregnancy.
* Two transducers are applied to the mother’s abdomen; one to record the FHR pattern and the other to record the uterine activity.
* Three uterine contractions per 10 minutes are induced by one of the following:
	+ IV oxytocin drip starting with 0.5mU/ minute and doubled gradually or
	+ tactile stimulation of the nipple.

***Results***

* Positive test: consistent and persistent late deceleration of FHR, so placental insufficiency is diagnosed and delivery by caesarean section is indicated.
* Negative test: late deceleration does not occur with uterine contractions. It denotes that the foetus can survive safely for one week when it should be repeated.

***Contraindications***

* Threatened preterm labour.
* Placenta praevia.
* Rupture of membranes.
* Previous classical C.S.
* Multiple pregnancy.

**BIOPHYSICAL PROFILE**

|  |  |  |
| --- | --- | --- |
| Variable | Score 2 | Score 0 |
| Foetal breathing movements | Last for 30 seconds in 30 minutes of observation. | Less than 30 seconds in 30 minutes of observation. |
| Foetal movements | 3 or more discrete body or limb movements within 30 minutes. | Less than 3 movements. |
| Foetal tone | One or more episodes of limb extension with return to flexion within 30 minutes. | Not observed. |
| Non-stress test | Reactive. | Non-reactive. |
| Amniotic fluid volume | One or more amniotic fluid pockets measures 1 cm or larger in 2 perpendicular planes. | Largest pocket measures less than 1 cm in 2 perpendicular planes. |
| Maximum score 10 Minimum score 0 |

* A score of 8-10 is normal.
* A score of 4-6 → deliver if lung is mature otherwise corticosteroids are given for 48 hours before delivery.
* A score of < 4 is abnormal → evaluate for immediate delivery.

**AMNIOTIC FLUID STUDY**

Procedure of amniocentesis: (see later).

**Detection of Foetal Maturity**

***Lung maturity***

* Lecithin/ sphingomyelin (L /S) ratio:
	+ Before 34 weeks of gestation, lecithin and sphingomyelin are present in the amniotic fluid in equal concentrations (1/1) . At about 35 weeks, the lecithin concentration rises so the ratio of L/S is 2/1 or more with this ratio the risk of respiratory distress is minimal.
* Phosphatidyl glycerol:
	+ Its detection in the amniotic fluid indicates lung maturity. It is more reliable than L/S ratio as it is not detected in blood, meconium or vaginal discharge so the contamination of the sample with any of these does not confuse the interpretation .
* Foam stability (shake) test:
	+ It is a rapid test for detection of foetal lung maturity.
	+ The test depends upon the ability of the surfactant in the amniotic fluid, when mixed with 95% ethanol in a glass tube and shacked well, to generate a ring of foam at the air-liquid interface that persists for at least 15 minutes.

***Kidney maturity***

Amniotic fluid creatinine level of 2 mg/ dl or more indicates foetal kidney maturity providing that maternal serum creatinine is normal .

***Liver maturity***

In absence of abnormal haemolysis, it is 0.01 -0.06 D OD at 34-36 weeks and continue to decrease up to term.

***Skin maturity***

The sebaceous glands of the foetus produce cells containing lipid so stained orange with Nile blue sulphate . If 50% or more of the cells in the amniotic fluid are of these type the foetus is mature.

**Detection of Foetal Abnormalities**

***Chromosomal abnormalities:***

such as Down’s syndrome (trisomy 21) can be diagnosed by examination of the desquamated foetal cells in the amniotic fluid.

Chromosomal study is indicated in the following conditions:

* Pregnant women of 35 years old or more as the incidence of Down's syndrome is increased to reach 1:50 when the mother is 40 years old or more.
* A previous chromosomally abnormal offspring.
* Chromosomal abnormality in either parents.
* Ultrasonographic markers of chromosomal anomalies as: cardiac defects, duodenal atresia, omphalocoele and hands or feet anomalies. Such markers are present in about 85% of foetuses with Down’s syndrome.

***Neural tube defects:***

as anencephaly and open spina bifida produce increased level of alpha fetoprotein into the amniotic fluid.

***Inborn metabolic errors***

* Amino -acid metabolism: e.g. cystinuria and histidinaemia.
* Carbohydrate metabolism: e.g. galactosaemia and glucose 6-phosphate dehydrogenase deficiency.
* Lipid metabolism: e.g. Tay-Sachs disease, Niemann-Pick disease and Gaucher’s disease.
* Miscellaneous disorders: e.g. congenital adrenal hyperplasia and congenital nephrotic syndrome.

***X- linked recessive disorders:***

e.g. Duchenne muscular dystrophy and haemophilia.

**Rh-isoimmunization:**

follow up of such patients by determination of the bilirubin level in the amniotic fluid.

**HORMONAL STUDIES**

**Oestriol**

* Maternal urinary and serum oestriol level is an important index for the integrity of the foetal adrenal and liver as well as the placenta.
* Urinary oestriol increases as pregnancy advances to reach about 35-40 mg/ 24 hours at full term. Progressive fall in urinary oestriol by serial measurement indicates that the foetus is jeopardous.

**Progesterone**

* Progesterone level can be detected in the serum and saliva of the pregnant mother and its end product pregnandiol in 24 hours collection of urine.
* It is of little practical value in comparison to urinary oestriol detection as the foetus is not sharing in its synthesis.

**Human Placental Lactogen (hPL)**

* Although it was found that hPL falls before foetal death, it may be within normal range until after foetal death.
* A single value of < 4 m g/ ml after 36 weeks is associated with 30% incidence of foetal distress.

**Human Chorionic Gonadotrophin (hCG)**

It has no practical value as it can be detected up to few weeks after foetal death or delivery.

**VAGINAL SMEAR**

* In good pregnancy: 95% of the cells in the smear are of the intermediate type (navicular cells) that have folded edges and present in clusters. About 5% of the cells are of the superficial type.
* In bad pregnancy: e.g. progesterone deficiency and placental insufficiency more than 10% of the cells are of the superficial type.
* In inevitable abortion: trophoblastic cells may appear in the smear.
* In intrauterine foetal death: parabasal cells appear in the smear.
* In antepartum rupture of membranes: foetal cells appear in the smear.
* At full term: 10% of the cells are of superficial type, clumping and folding of the intermediate cells become less evident due to decreasing progesterone level.

**AMNIOSCOPY**

Introduced through the cervix without rupturing the membranes. It may reveal meconium stained liquor indicating placental insufficiency.

**FOETOSCOPY**

Direct visualisation of the foetus by fibroptic telescope introduced through the abdominal and uterine walls.

**Benefits:**

* Direct visualisation of congenital anomalies: e.g.
	+ Polydactyly.
	+ Limb reductions.
	+ Cranial and facial anomalies.
	+ Neural tube defects.
	+ Exomphalos.
* Foetal blood sampling for prenatal diagnosis of:
	+ Haemoglobinopathies.
	+ Haemophilia.
	+ Galactosaemia.
	+ Duchenne muscular dystrophy.
	+ Genetic diagnosis.
* Foetal skin biopsy for diagnosis of e.g.
	+ Epidermolysis bullosa.
	+ Detailed cytogenetic pattern.

**CHORIONIC VILLUS BIOPSY**

Transcervical or transabdominal sampling of chorionic (placental) tissue from the interior of the first trimester pregnant uterus for prenatal diagnosis of:

* Chromosomal anomalies.
* X-linked anomalies.
* Metabolic inborn errors.
* Haemoglobinopathies.
* Transplacental infections as rubella, toxoplasma and cytomegalovirus.

**RADIOLOGICAL METHODS**

**Amniography**

Injection of water soluble radiopaque material as urographin into the amniotic fluid to outline the foetus during X-ray radiography.

**Foetography**

Injection of oil-soluble radiopaque material as Ethiodol into the amniotic fluid to outline the foetus as it has a strong affinity to vernix caseosa giving a clearer view in X-ray radiography.

Radiological methods are abandoned since the development of sonography as these have the following hazards:

* Hazards of radiation and radiopaque materials.
* Injury to the foetus.
* Infection.
* Less obtained data than sonography.

**MONITORING OF FOETAL HEART RATE**

**Intermittent Auscultation**

By: - Pinard’s stethoscope, or - Doptone (Sonocaid).

**Electronic Monitoring**

***Foetal electrocardiography (ECG)***

* External: by external electrodes applied to the mother’s abdomen.
* Internal: by an internal electrode applied to the foetal scalp after rupture of the membranes while the cervix should be one or more cm dilated.
	+ The electrode is held manually or fixed with clip or screw. A second electrode lies in contact with the vagina or cervix.
	+ The signal is transmitted by wire to an amplifier or paper strip record.

***Phonocardiography***

A sensitive microphone amplifier is used to amplify the foetal heart sounds auscultated through the maternal abdominal wall.

***Doppler ultrasound cardiography***

* An external transducer applied to the mother’s abdomen is used to detect the blood flow in the umbilical cord and great vessels .
* If it is associated with recording of uterine contractions, it is called cardiotocography (CTG).

**Interpretation of FHR**

**Baseline FHR changes**: The pattern between uterine contractions.

* Baseline tachycardia:
	+ Mild: 160-180 beats/min. - Severe: > 180 beats / min.
* Baseline bradycardia:
	+ Mild: 100-120 beats/min. - Severe: <100 beats/ min.
* Loss of beat - to - beat variation:
	+ Normally there is a change of 5-10 beats/ minute every minute in FHR. Absence of this beat -to - beat variation indicates foetal compromise.

**Periodic FHR changes**: The pattern with uterine contractions.

* Early deceleration:
	+ Decrease in the FHR with the onset of the uterine contraction and return to the baseline with the end of the contraction.
	+ This is usually due to compression of the foetal head with vagal stimulation.
* Late deceleration:
	+ Decrease in the FHR starts after a lag time from the onset of contraction and ends after a lag time from its end.
	+ It denotes uteroplacental insufficiency.
* Variable deceleration:
	+ of different intensity, pattern, time of onset and offset.
	+ It usually denotes cord compression.

**MONITORING OF UTERINE CONTRACTIONS (TOCOGRAPHY)**

**External (CTG)**

An external transducer is applied to the mother’s abdomen close to the fundus transmitting the strength, frequency and duration of uterine contractions onto a paper strip record.

**Internal**

A fluid-filled catheter is introduced into the uterus after rupturing the membranes. The intrauterine pressure is transmitted to the catheter then to a transducer giving electrical signals expressing the exact pressure in mmHg.

**FOETAL BLOOD SAMPLING**

**Cordocentesis**

Transabdominal passage of a needle into the umbilical vessels for blood sampling or administration of therapy which may be hysteroscopic or ultrasonographic guided.

Indications:

* Diagnostic for:
	+ Hereditary disorders.
	+ Foetal hypoxia.
	+ Genetic disorders and karyotyping: replaced by chorionic villus biopsy.
* Therapeutic for:
	+ Foetal anaemia particularly due to Rh-isoimmunization.

**Foetal Scalp Blood Sampling**

After rupturing the membrane, a special guarded needle is introduced through an amnioscope to take a drop of scalp blood for detection of its pH.

* pH of 7.25 or more is normal,
* pH of 7.20 or less denotes acidosis,
* values in-between denotes pre-acidotic range and repeated estimation is indicated.

**PARTOGRAM**

see before.

**RECENT ADVANCES IN INTRANATAL MONITORING**

* Telemetry: radiotelemetry of the FHR and uterine contractions pattern to a 50-100 meters distant monitor.
* Computerised data analysis: Analysis of the various parameters including FHR and uterine activity. A computerised prognostic comment is also developed.
* Foetal electroencephalography (EEG).
* Continuous foetal tissue pH or PO2 measurement.
* Maternal and foetal blood lactate measurement.